P1 1128088

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

February 13, 2004

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: *60/456,015*
FILING DATE: *March 19, 2003*
RELATED PCT APPLICATION NUMBER: *PCT/US03/38301*

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

M. Tarver

M. TARVER
Certifying Officer

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

03/20/03 0456015 031903 AT PROV

PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(b)(2).

Docket Number	60,152-944	Type plus sign (+) inside this box	+

INVENTOR(S)/APPLICANT(S)

LAST NAME	FIRST NAME	MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY)
Woods	Harold	T.	45414 Augusta Drive Canton, Michigan 48188, USA

TITLE OF THE INVENTION (280 characters max)

SELF-DIAGNOSING PIERCE NUT INSTALLATION APPARATUS

CORRESPONDENCE ADDRESS

Raymond E. Scott
The Pinehurst Office Center, Suite #101
39400 North Woodward Avenue
Bloomfield Hills

STATE	Michigan	ZIP CODE	48304-5151	COUNTRY	United States

ENCLOSED APPLICATION PARTS (*check all that apply*)

☒ Specification *Number of Pages* 16 ______This applicant claims entitlement to Small Entity Status
☒ Drawing(s) *Number of Sheets* 5 Other (specify) ______

METHOD OF PAYMENT (*check one*)

☒ A check or money order is enclosed to cover the Provisional filing fees
☒ The Commissioner is hereby authorized to charge any filing fee deficiencies and credit any overpayments to Deposit Account Number: 08-2789

PROVISIONAL FILING FEE AMOUNT ($) 160.00

CUSTOMER NO. 27305

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
☒ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,
SIGNATURE [signature]
TYPED or PRINTED NAME Raymond E. Scott

Date March 19, 2003
REGISTRATION NO 22,981
(*if appropriate*)

☐ Additional inventors are being named on separately numbered sheets attached hereto

PROVISIONAL APPLICATION FILING ONLY

PTO/SB/17 (11-01)
Approved for use through 10/31/2002. OMB 0651 -0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 160.00

Complete if Known	
Application Number	Herewith
Filing Date	March 19, 2003
First Named Inventor	Harold T. Woods
Examiner Name	Not Yet Assigned
Group Art Unit	Not Yet Assigned
Attorney Docket No.	60,152-944

METHOD OF PAYMENT (*check all that apply*)

☒ Check ☐ Credit Card ☐ Money Order ☐ Other ☐ None

☐ Deposit Account

Deposit Account Number: 08-2789

Deposit Account Name: Howard & Howard Attorneys, P.C.

The Commissioner is authorized to: (*check all that apply*)

☐ Charge fee(s) indicated below ☒ Credit any overpayments

☒ Charge any additional fee(s) during the pendency of this application

☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	740	201	370	Utility filing fee	
106	330	206	165	Design filing fee	
107	510	207	255	Plant filing fee	
108	740	208	370	Reissue filing fee	
1005	160	214	80	Provisional filing fee	160.00

SUBTOTAL (1) ($) 160.00

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

		Extra Claims	Fee from below	Fee Paid
Total Claims	-20** =	x	=	
Independent Claims	-3** =	x	=	
Multiple Dependent			=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claims, if not paid
109	84	209	42	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0.00

***or number previously paid, if greater; For Reissues, see above*

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provision filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for *ex parte* reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner application	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	920	217	460	Extension for reply within third month	
118	1,440	218	720	Extension for reply within fourth month	
128	1,960	228	980	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing a brief in support of an appeal	
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,280	241	640	Petition to revive - unintentional	
142	1,280	242	640	Utility issue fee (or reissue)	
143	460	243	230	Design issue fee	
144	620	244	310	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR § 1.17(q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	740	246	370	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	740	249	370	For each additional invention to be examined (37 CFR § 1.129(b))	
179	740	279	370	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid **SUBTOTAL (3)** ($) 0.00

SUBMITTED BY

Name (*Print/Type*)	Raymond E. Scott	Registration No. (*Attorney/Agent*)	22,981	Telephone	248.723.0306
Signature				Date	March 19, 2003

Complete (*if applicable*)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

G:\Wabriste\lp00944\patent\Fee Transmittal Form 3-19-03.doc

60456015 .031903

CERTIFICATE OF EXPRESS MAILING

I hereby certify that the enclosed **PROVISIONAL PATENT APPLICATION** and fee are being deposited with the United States Postal Service as Express Mail, postage prepaid, in an envelope as "Express Mail Post Office to Addressee", Mailing Label No. **EV227251759US** and addressed to **Box Provisional Application,** Assistant Commissioner for Patents, Washington, D.C. 20231 on **March 19, 2003.**

Tracy L. Smith

G:\f\fabriste\ip00944\patent\PRV APP TRANSMIT 3-19-03.doc

EXPRESS MAIL LABEL NO. EV227251759US

SELF-DIAGNOSING PIERCE NUT INSTALLATION APPARATUS

Inventor(s): Harold T. Woods

Address: 45414 Augusta Drive
Canton, Michigan 48188, USA

Atty. Docket No.: 60,152-944

docket #60,152-944

SELF-DIAGNOSING PIERCE NUT INSTALLATION APPARATUS

FIELD OF THE INVENTION

[00001] This invention relates to a pierce nut installation apparatus which continuously monitors the pierce nut installation and automatically shuts down the die press in the event that the last pierce nut is not properly installed.

BACKGROUND OF THE INVENTION

[00002] As will be understood by those skilled in this art, pierce nuts are typically installed in a metal plate or panel by an installation apparatus including a head generally attached to the upper die platen or shoe of a reciprocating die press and a die member or die button installed in the lower die shoe or die platen, wherein the panel is fixed to the lower die shoe or die platen overlying the die button. Pierce nuts are fed to the installation head opposite a reciprocating plunger which, upon closing of the die press, drives the pierce nut into the panel, piercing a slug from the panel, and the die button then installs the pierce nut in the pierced panel opening. The slug pierced from the panel is then received in an opening in the die button, which typically retains several slugs before ejecting the slugs.

[00003] The panel may be simultaneously formed by the die press and several pierce nuts may be simultaneously installed in the panel with each stroke of the die press particularly in mass production applications. On occasion, through misalignment or improper nut installation, the panel slug may remain attached or partially attached to the panel causing potential quality issues during the assembly operation, wherein the panel having the pierce nut attached is assembled to a second component. In the automotive industry, for example, the assembly operation is

carried out at a different location. Another problem associated with the installation of pierce nuts is the stacking of the panel slugs in the die button opening. The stack of slugs may "cold weld" together, forming a barrier to the entrance of further slugs and resulting in a poor or partial installation of the pierce nuts or requiring greater force to push out the slugs. It is not always possible to visually inspect the opening through the die button, particularly in time to shut down the die press to avoid improper installation of further pierce nuts. Further, the improper installation of the pierce nuts described above may not be discovered until later in the assembly process.

[00004] It would therefore be very desirable to monitor the pierce nut installations during the installation of the pierce nuts and simultaneously monitor the slugs pierced from the panel during installation. However, the prior art does not disclose an apparatus or method capable of continuously monitoring these problems and potential problems with the installation of pierce nuts.

SUMMARY OF THE INVENTION

[00005] The pierce nut installation apparatus of this invention is self-monitoring. That is, the pierce nut installation apparatus of this invention continuously monitors the installation of pierce nuts by the pierce nut installation head and the slugs pierced from the panel to assure continued proper installation of pierce nuts. The sensors in the pierce nut installation apparatus of this invention is connected to the computer logic of the die press. In the event that the sensor system determines that a pierce nut has not been installed in the panel or that a slug has not been pierced from the panel and received through the die button, the press is stopped at the top of the stroke for maintenance of the pierce nut installation head, permitting

immediate correction of the problem and avoiding incorrectly installed pierce nuts and potential scrap of the panel assembly.

[00006] The pierce nut installation head of this invention includes a plunger passage and a pierce nut feed passage intersecting the plunger passage. A feed mechanism feeds pierce nuts through the feed passage into the plunger passage opposite a reciprocating plunger in the plunger passage. Upon closing of the die press, the plunger reciprocates through the plunger passage to install a pierce nut in a panel supported on a die button as described above. A conventional pierce nut includes a projecting pilot portion, flange portions on at least opposed sides of the pilot portion and a bore extending through the pilot portion. The pilot portion pierces a slug from the panel and the die button deforms the panel metal adjacent the pierced panel opening into grooves in the pierce nut, permanently attaching the pierce nut to the panel. The pierced panel slug is then received in a central opening in the die button.

[00007] In a preferred embodiment of the pierce nut installation head of this invention, a slug probe rod is received through the plunger having a proximal end generally parallel to the proximal end of the plunger, opposite the pierce nut in the plunger passage when the die press is in the open position, and a distal end which is resiliently biased toward the proximal end of the plunger. The slug probe rod has an axial length greater than the axial length of the plunger such that, upon closing of the die press, the slug probe rod extends through the plunger into the pierce nut bore a distance greater than the thickness of the pierce nut if a slug has been pierced from the panel. If a slug has not been pierced from the panel, the proximal end of the slug probe rod will engage the panel. As will be understood by those skilled in this art, the distal end of the plunger of a conventional pierce nut installation head may be fixed to

or spaced from the back-up plate attached to the upper die platen. Upon closing of the die press, the distal end of the plunger engages the back-up plate and the proximal end of the plunger drives the pierce nut through the plunger passage. Because the slug probe rod has a greater axial length than the plunger and is resiliently biased toward the proximal end of the plunger, the proximal end of the slug probe rod is then received into the bore of the pierce nut to either engage the panel, if a slug has not been fully pierced from the panel, or through the nut bore if a slug has been pierced from the panel. The slug probe rod also serves the function of removing a slug from the panel in the event that a slug is partially pierced from the panel and hanging, for example, from the panel. A sensor of the pierce nut installation head then determines whether the slug probe rod has been received through the pierce nut bore and signals the computer logic of the die press to recycle the die press and install a second pierce nut. However, if the sensor determines that the slug rod probe has not been received through the pierce nut bore, the sensor signals the computer logic of the die press to stop the press when the press is open for inspection and maintenance as required.

[00008] In one preferred embodiment, the slug probe rod is mechanically biased toward the proximal end of the plunger by a conventional coil spring. In this embodiment, the distal end of the slug probe rod includes an enlarged head portion and the spring is biased against the enlarged head portion of the slug probe rod. In an alternative embodiment, the slug probe rod is resiliently biased toward the proximal end of the plunger by pneumatic pressure. In this alternative embodiment, the back-up plate includes a bore which receives an enlarged distal end of the slug probe rod has an O-ring or other sealing means and pneumatic pressure resiliently biases the slug probe rod toward the proximal end of the plunger. As used herein, the term "proximal" refers to a component or a portion of a component closest

to the pierce nut feed passage or the pierce nut in the plunger passage and the term "distal" refers to a component or a portion of a component furthest from the pierce nut feed passage or the pierce nut located in the plunger passage. As will be understood, these terms are for descriptive purposes only. In the disclosed embodiments, the pierce nut installation head of this invention includes a probe or sensor which senses the location of the distal end of the slug probe rod.

[00009] As set forth above, the self-monitoring pierce nut installation apparatus of this invention also determines whether a panel slug is received through the die button indicating that the panel has not only been pierced, but also that the pierced panel slug has been fully removed from the panel and received through the die button. In the current design of the pierce nut die button, the die button retains several slugs which, on occasion, can cold weld together, blocking the opening through the die button and resulting in improper installation of the pierce nuts or requiring greater force to remove the slugs. Another problem is that the slug may only be partially pierced from the panel and hangs from the panel. As set forth above, the pierce nut installation apparatus of this invention includes a slug sensor which determines whether the pierced panel slug is received through the central opening or bore in the die button.

[00010] The slug sensor is also connected to the computer logic of the die press. If a slug is received through the opening through the die button, the sensor signals the computer logic of the die press to recycle the press and install a second pierce nut as described above. If, however, the slug sensor indicates that a slug has not been received through the central opening of the die button, the sensor signals the computer logic of the die press to stop the press in the open position for corrective maintenance. In one embodiment of the pierce nut installation head of this invention,

the pierce nut installation head includes a sensor ring having an opening coaxially aligned with the opening through the die button and a conductive coil surrounds the opening of the ring sensor which creates a magnetic field which signals that a slug has been received through the opening through the die button. As will be understood, the conductive coil can also be located at the exit of the central opening of the die button. In an alternative embodiment, the sensor includes an infrared beam or similar sensing device which senses the ejection of the pierced panel slug.

[00011] As will be understood, the slug probe rod sensor and the slug sensor of the pierce nut installation apparatus of this invention may be utilized individually or in combination, but the preferred embodiment of the pierce nut installation head of this invention includes both features.

BRIEF DESCRIPTION OF THE DRAWINGS

[00012] Sheet 1, drawing No. D-131099, illustrates one embodiment of the pierce nut installation head of this invention;

[00013] Sheet 2, drawing No. D-129887, illustrates an alternative embodiment of the pierce nut installation head of this invention;

[00014] Sheet 3, drawing No. C-131121, illustrates one embodiment of an improved die button of this invention;

[00015] Sheet 4, drawing No. B-131311, illustrates a slug sensor assembly; and

[00016] Sheet 5 illustrates the sequence of installation of a pierce nut with the pierce nut installation apparatus of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[00017] Sheet 1 illustrates a pierce nut installation head of this invention including a top view shown in Figure 1, an end view shown in Figure 2, a perspective view shown in Figure 3 and a cross-sectional view shown in Figure 4 through section line Z-Z in Figure 1. Reference 1 in Figure 4 of Sheet 1 is a conventional nose assembly of a pierce nut installation head having a plunger passage 30 and a pierce nut feed passage 32 intersecting and communicating with the plunger passage 30. Pierce nuts (not shown in Sheet 1, but shown at 48 in Sheet 5) are fed through the feed passage 32 by a conventional feed assembly 8 having a feed pawl 34 when the die press (not shown) is opened. As will be understood by those skilled in this art, the base assembly includes a mounting block or back-up plate 4 which is attached to the upper die shoe or die platen of a conventional die press. The base assembly further includes a shank assembly 2 which is fixed to the nose assembly 1 by the chute attaching block lock pin 13 having a coil shank spring 9 which is biased against the upper die platen thereby normally spacing the nose assembly 1 from the base assembly 3 when the die press is opened. The base assembly further includes an inclined surface 36 and the feed assembly 8 normally includes a roller (not shown) which is received against the inclined surface 36, driving the feed assembly 8 to the right in Figure 4 when the die press is closed. The feed assembly 8 also includes a coil spring 38 which drives the feed pawl 34 to the left in Figure 4 or toward the nose assembly 1 when the die press is opened during feeding of a pierce nut from the feed passage 32 to the plunger passage 30. The pierce nut installation head further includes a reciprocating plunger 5 received in the plunger passage 40 of the cam base assembly 3 and 4 having a distal end 42 normally spaced from the back-up plate 4 by

spring 9. The proximal end 44 of the plunger 5 is normally located just above the plane of the feed passage 32 as shown in Figure 4.

[00018] Upon closing of the die press, the nose assembly 1 first engages a panel "P" supported on a die button 46 as shown in Sheet 5, Figure 1, which drives the nose assembly 1 toward the cam base assembly 3 and 4, against the force of the spring 9, which drives the proximal end 44 of the plunger against a pierce nut 48 in the plunger passage as shown in Figure 1 of Sheet 5 until the distal end 42 engages the back-up plate 4 as shown at Figure 2 of Sheet 5. Upon closing of the die press, the distal end 42 of the plunger 5 engages the back-up plate 4 and drives the pierce nut 48 into the panel P piercing a slug from the panel as shown in Figure 3 of Sheet 5 and the die button 46 then deforms the panel metal surrounding the pierced panel opening into grooves of the pierce nut 48 securing the pierce nut in the pierced panel opening. As thus far described, the pierce nut installation head may be conventional. Upon opening of the die press, the spring 9 drives the nose assembly toward the position shown in Figure 4 of Sheet 1 and the feed assembly 8 drives another pierce nut into the plunger passage 30, ready for installation. Although the pierce nut installation head thus far described is reliable for mass production applications, on occasion the panel slug shown in Figure 3 of Sheet 5 will not be severed or fully severed from the panel or retained in the die button resulting in an improper installation.

[00019] The pierce nut installation apparatus of this invention will immediately indicate either of these conditions and hold the die press in the open position for immediate diagnosis, maintenance or repair. The pierce nut installation head shown in Sheet 1 includes an elongated slug probe rod 22 which is telescopically received in a bore 50 through the plunger 5 having a proximal end 52 adjacent the

proximal end 44 of the plunger 5 and a distal end 54 received in an opening or bore 56 in the back-up or mounting plate 4 as shown in Figure 4 of Sheet 1. In this embodiment, a coil suspension spring 20 is biased between the enlarged head portion 54 of the slug probe rod 22 and the upper die show of the die press (not shown). As will be understood from the above description, the back-up plate 4 is mounted on the upper die platen of the die press (not shown) and thus the spring 20 is compressed between the upper die platen and the enlarged head 54 of the slug probe rod 22. In the preferred embodiment, the proximal end 52 of the slug probe rod 22 is generally parallel with, but preferably spaced upwardly from the proximal end 44 of the plunger 5 as shown in Figure 4 of Sheet 1. However, the slug probe rod 22 has an axial length greater than the axial length of the plunger 5. The pierce nut installation head of this invention further includes a proximity probe 19 which indicates the position of the enlarged head portion 54 of the slug probe rod and thus whether the slug probe rod is moved axially against the force of the spring 20. The proximity probe 19 is connected to the computer logic of the die press. In the event that the slug probe rod is driven distally into the bore 56 in the back-up plate 4 against the force of the spring 20, this indicates that a panel slug shown in Figure 3 of Sheet 5 has not been fully pierced from the panel. As shown in Figure 2 of Sheet 5, the proximal end 52 of the slug probe rod 22 is initially received into the bore of the nut 48 and against the panel P. However, when the panel is pierced, the proximal end 52 is received through the nut bore indicating that a slug has been pierced from the panel as shown in Figure 3 and a pierce nut has been installed in a panel. The spring biased slug probe rod 22 has an additional advantage of removing a slug from the panel if the slug is partially pierced from the panel and, for example, hanging from the panel at an obtuse angle relative to the plane of the panel. As set forth above, the proximity probe 19 is connected to the

computer logic of the die press. In the event that the proximal end 52 of the slug probe rod is not received through the bore of the nut 48 upon closing of the die press, the proximity probe 19 signals the computer logic of the die press and the computer logic of the die press will then indicate a "no go" situation and hold the press in the open position for maintenance or repair. As will be understood by those skilled in this art, the slug probe rod 22 may be used with any design of a pierce nut installation head and is not limited to the pierce nut installation head described.

[00020] As described further below, the proximity probe 19 may be replaced with an infrared sensor which eliminates the requirement for a wire from the proximity probe extending from the side of the head. In such embodiment, the slug probe rod 22 includes an axial bore with an infrared sensor located opposite the distal end 54 of the slug probe rod 54 which projects an infrared beam through the slug probe rod which is reflected off the panel in the event that a slug has not been pierced from the panel.

[00021] Sheet 2 illustrates an alternative embodiment of the pierce nut installation head shown in Sheet 1 wherein the primary modification relates to the slug probe rod which is numbered 33 in Sheet 2. In this embodiment, the plunger 5 is fixed to the punch support cam base 3 by a dowel pin 20 and the proximal end 60 of the slug probe rod 33 is approximately parallel to or spaced slightly above the proximal end 62 of the plunger 5 when the die press is open as shown in Figure 4 of Sheet 2. The slug probe rod 33 in this embodiment includes an enlarged cylindrical end portion 68 having cylindrical radial portions 70 and an O-ring 23 is received between the radial portion 70 and the assembly includes a molded urethane spring 16. Pneumatic pressure is received through port 13, which resiliently biases the slug probe rod 33 proximally against the force of the return spring 24. Except that the slug

probe rod 33 is resiliently biased by pneumatic pressure and the assembly includes a return spring 24, the function and operation of the slug probe rod 33 is identical to the slug probe rod 22 described above in regard to Sheet 1 of the drawings and therefore no further description is required for a full understanding of the pierce nut installation head shown in Sheet 2.

[00022] Sheet 3 illustrates an improved die button utilized with the self-diagnosing pierce nut installation apparatus of this invention, wherein Figure 1 of Sheet 3 is a side view of the die button, Figure 2 is a top view, Figure 3 is a cross-sectional view in the direction of view arrows B-B, Figure 4 is a cross-sectional side view of Figure 2 in the direction of view arrows C-C, and Figure 5 is a partial side cross-sectional view of Figure 2 in the direction of view arrows Z-Z. As shown in Figure 2, the die button includes a planar end face 72 having a projecting generally rectangular lip 74 having a sharp inner edge 76 which, in cooperation with the pilot portion of the pierce nut, pierces the slug from the panel. An opening 78 extends through the lip 74 and a central opening 80 extends through the die button as shown in Figure 1. The die button of this invention differs from the die buttons presently used in that the inner wall 78 is tapered radially outwardly from the lip 74 at a back angle of between 2 to 7 degrees or more, preferably 3 and 5 degrees, such that the panel slugs pierced from the panel shown in Figure 3 of Sheet 5 are not collected in the opening 78, but instead fall through the tapered opening into the main passage 80 assuming that the panel slug is fully pierced from the panel as described above. An angle of 3 to 5 degrees does not adversely affect the strength or integrity of the clinching lip 74 and has been found by experimentation by the Applicant to permit full ejection of the slug through the die button without decreasing the life of the die button, which has been a problem in many applications.

[00023] Finally, Sheet 4 illustrates one embodiment of a slug sensor 82 also shown schematically in Sheet 5. The slug sensor assembly shown in Sheet 4 of the drawings includes riser plates 84 and 86 on opposed sides of a proximity ring sensor 88. The ring sensor includes a conductive metal coil 90 (shown in Sheet 5) which surrounds the opening 92 through the ring sensor 88. In the disclosed embodiment, the upper riser plate 86 includes a frustoconical opening 94 having a minor diameter generally equal to the diameter of the cylindrical bore 92 through the ring sensor 88 and the lower riser plate 84 includes a cylindrical opening 96 slightly larger than the cylindrical opening 92 through the ring sensor. The assembly is bolted to a suitable fixture by bolts 98, such that the openings 92, 94 and 96 are coaxially aligned with the opening through the die button as shown schematically in Sheet 5.

[00024] As will be understood by those skilled in this art, a metal part such as a panel slug received through the opening 92 of the ring sensor 88 will generate a magnetic field and the ring sensor 88 includes a connector 100 which is connected to the computer logic of the die press, such that the press shuts off in the event that a slug is not received through the opening 92 in the ring sensor. Of course, if a slug is received through the ring sensor 88, the press recycles as described above to install a second pierce nut or a plurality of pierce nuts in a second panel.

[00025] The self-diagnosing pierce nut installation apparatus of this invention thus senses whether a pierce nut has been installed in a panel and whether a slug has been fully pierced from the panel and automatically stops the press cycle in the event that a slug is only partially pierced from the panel or a pierce nut has not been installed in the panel. The die press is stopped in the open or upper position providing full access to the installation apparatus.

[00026] As will be understood by those skilled in this art, various modifications may be made to the self-diagnosing pierce nut installation apparatus of this invention within the purview of the appended claims. For example, the slug probe rod may be resiliently biased proximally by any suitable means including but not limited to a spring as shown in Sheet 1 and pneumatic pressure is shown in Sheet 2.

[00027] As described above, the proximity probe shown at 19 in sheet 1 and 25 in sheet 2 may be replaced by an infrared sensor, wherein the slug probe rod includes an axial bore therethrough and the assembly includes an infrared sensor opposite the distal end of the slug probe rod which projects an infrared beam through the slug probe rod. In the event that a slug has not been pierced from the panel, the infrared beam is reflected by the panel back to the infrared sensor to indicate whether a slug has been pierced from the panel. Alternative sensors may also be utilized. Further, the slug sensor shown in Sheet 4 of the drawings may be replaced with an infrared sensor or any suitable sensor which senses the passing of the slug through the opening 80 through the die button. Further, the conductive coil 90 may surround the opening 80 through the die button. Having described preferred embodiments of the pierce nut installation apparatus of this invention, the invention is now claimed as follows.

CLAIMS

1. A pierce nut installation apparatus for installing pierce nuts having a bore in a panel, comprising: a pierce nut installation head including a pierce nut feed passage, a plunger passage intersecting said feed passage receiving pierce nuts from said feed passage, a plunger reciprocating in said plunger passage having a bore therethrough and a proximal end driving pierce nuts through said plunger passage into a panel opposite said plunger passage and piercing an opening in said panel, a slug probe rod reciprocally supported in said bore of said plunger resiliently biased toward said proximal end of said plunger adapted to be received through said nut bore against a panel in the event that an opening is not pierced in said panel, and a sensor sensing movement of said slug probe rod to determine whether an opening has been pierced in said panel.

2. The pierce nut installation apparatus as defined in Claim 1, wherein said slug probe rod has an axial length greater than an axial length of said plunger and said slug probe rod having a proximal end adjacent said proximal end of said plunger prior to reciprocal movement of said plunger.

3. The pierce nut installation apparatus as defined in Claim 1, wherein said slug probe rod is spring biased toward said proximal end of said plunger.

4. The pierce nut installation apparatus as defined in Claim 1, wherein said slug probe rod is resiliently biased toward said proximal end of said plunger by pneumatic pressure and said slug probe rod including a return spring biasing said slug probe rod away from said proximal end of said plunger.

5. The pierce nut installation apparatus as defined in Claim 1, wherein said slug probe rod has an enlarged distal end and said sensor detecting movement of said enlarged distal end of said spring probe rod.

6. The pierce nut installation apparatus as defined in Claim 1, wherein said pierce nut installation apparatus includes a die button opposite said plunger passage supporting said panel having an opening coaxially aligned with said plunger passage and a slug sensor detecting receipt of a panel slug pierced from said panel and received through said opening in said die button.

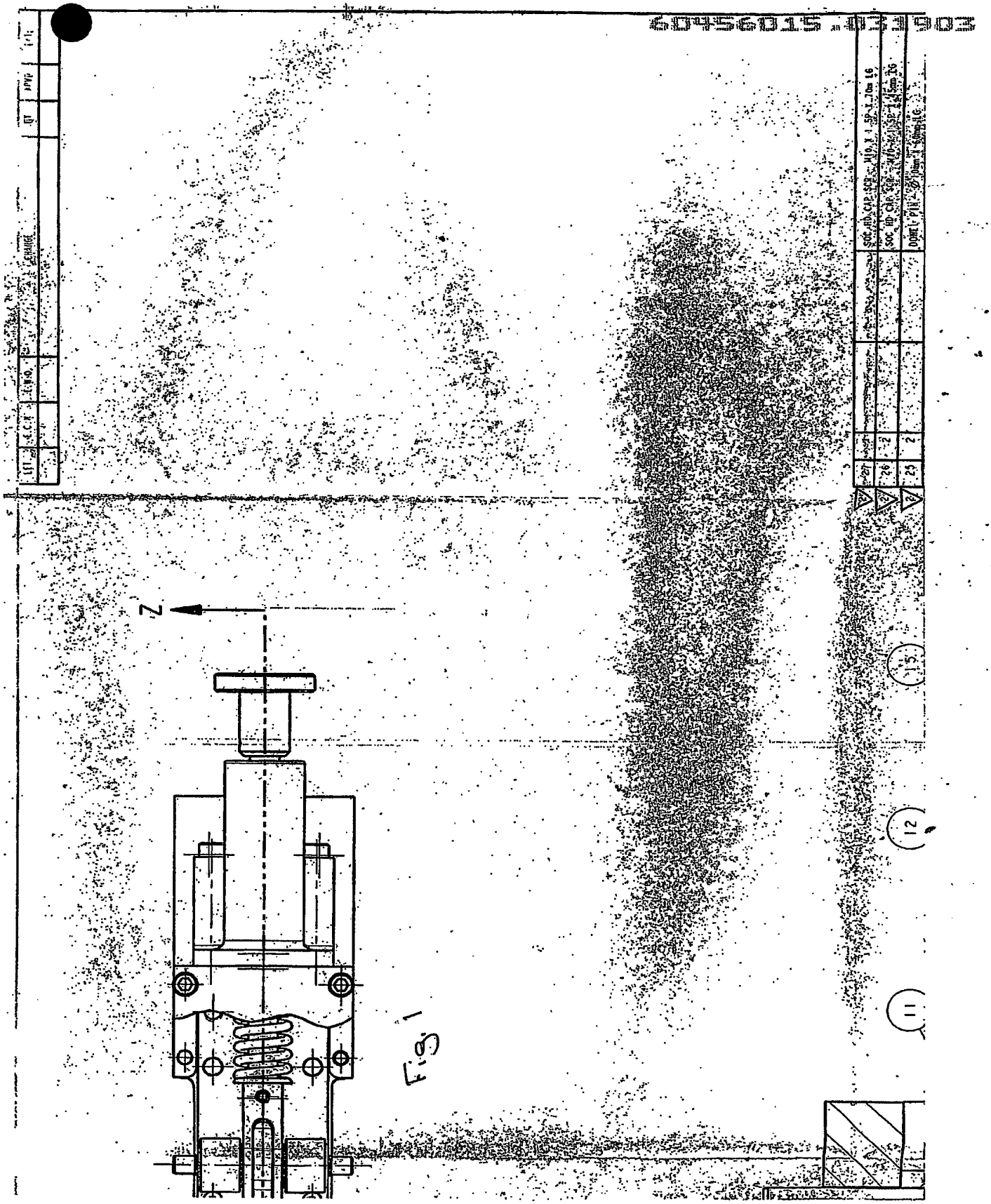
7. The pierce nut installation apparatus as defined in Claim 6, wherein said slug sensor includes a conductive coil surrounding an opening in said sensor receiving said panel slug and said panel slug creating a magnetic field.

8. A pierce nut installation apparatus for installing pierce nuts having a nut bore in a panel, comprising: a pierce nut installation head including a pierce nut feed passage, a plunger passage intersecting said pierce nut feed passage receiving pierce nuts from said pierce nut feed passage, a plunger reciprocating in said plunger passage having a proximal end driving pierce nuts through said plunger passage into a panel opposite said plunger passage and said pierce nut piercing a slug from said panel forming an opening through said panel receiving said pierce nut, and a die button opposite said plunger passage supporting said panel having an opening coaxially aligned with said plunger passage and a slug sensor having an opening therethrough coaxially aligned with said opening through said die button detecting receipt of a panel slug pierced from said panel and received through said opening in said sensor.

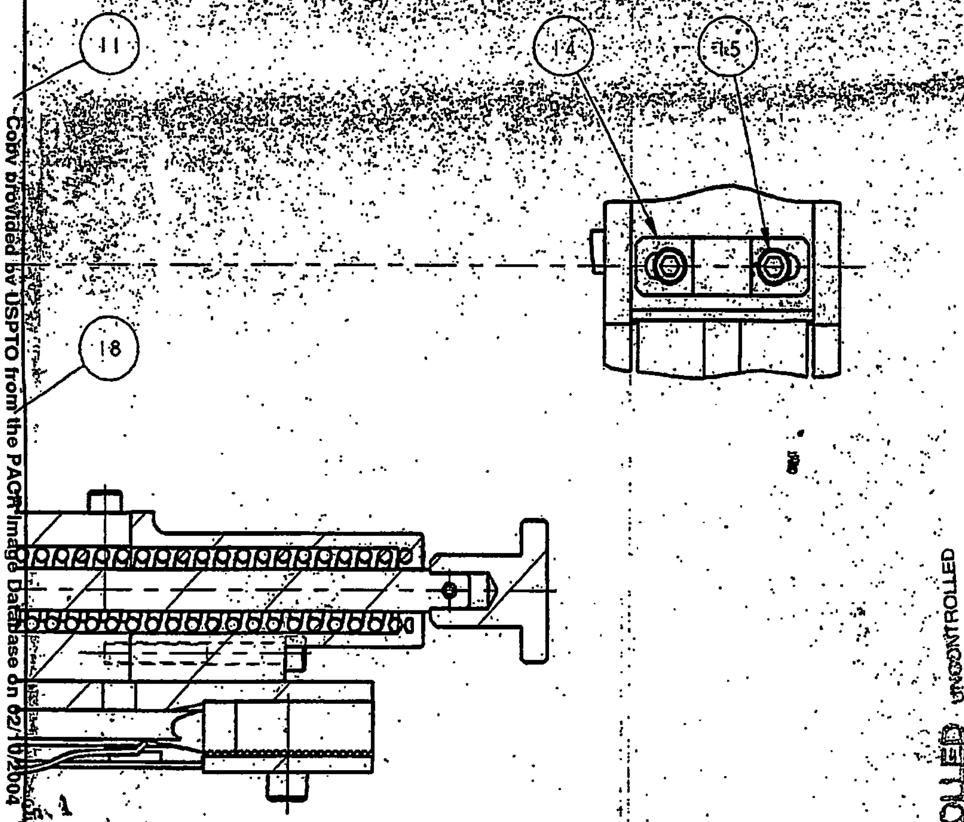
9. The pierce nut installation apparatus as defined in Claim 8, wherein said sensor includes a conductive coil surrounding said opening through said sensor receiving said panel slug, said conductive coil creating a magnetic field upon receipt of said panel slug.

10. The pierce nut installation apparatus as defined in Claim 8, wherein said plunger includes a bore therethrough and a slug probe rod reciprocally supported in said bore of said plunger resiliently biased toward said proximal end of said plunger adapted to be received through said nut bore against said panel in the event that an opening is not pierced in said panel, and a slug probe rod sensor sensing movement of said slug probe rod to determine whether an opening has been pierced in said panel.

11. The pierce nut installation apparatus as defined in Claim 10, wherein said slug probe rod has an axial length greater than an axial length of said plunger and said slug probe rod having a proximal end adjacent said proximal end of said plunger prior to reciprocal movement of said plunger.



60456015 .031903



UNCONTROLLED UNCONTROLLED COPY

DET	QTY	PART No.	DRAWING No.	DESCRIPTION
34	1	HS-60-PT01-CT	C-125018-A	1.50 EXT. - W/ PROX & T-BAR
33	1	129890	C-129890	SLUG PROBE ROD
32	1	NP-CON-02-L50	C-104782	SHANK - 1.50 EXT.
31	1	HSNC-60-29	C-104103	REEL-FEED ADAPTER ASSY
30	1	129355	B-129355	PROBE RETAINER
29	1	129240	B-129240	PROX ASSY - SPECIAL
28	1	129131	B-129131	PROX CLIP
27	1	NSE-7PNP-CA	B-126328	ASSY PROX NUT SENSING PROBE W/ QUICK DISCONNECT
26	2	HS-60-06	B-104482	NUT HOLDER FINGER HI-60 NUT
25	1	503038	A-503038	TURCK PROX
24	1	503037	A-503037	SPRING
23	2	502977	A-502977	PARKER O-RING (42-010)
22	1	501523	A-501523	SOC HD CAP SCR M3 X 0.5P X 6mm LG
21	1	MS-172	A-500938	HOSE FITTING #10-32 TO 1/8 BARB
20	1	500256	A-500256	DOWEL PIN .2500 x .38 LG.
19	2	MS-140	A-500017	SOC HD CAP SCR #10-32 X 1 1/4 LG.
18	2	MS-14	A-500002	SHCS 3/8-24 UNF-2A THD X 1.50 LG.
17	2	MS-20	A-500172	PLUG 1/8-27 NPT
16	2	129892	A-129892	MOLDED URETHANE SPRING
15	2	MS-16	A-500004	SOC HD CAP SCR #10-32 X 3/8 LG
14	1	MS-4H	A-103973	RETAINER PLATE STOP PIN
13	1	NSE-05	A-101177	TUBING
12	1	MS-5	A-101078	CHUTE ATTACHING BLOCK LOCK PIN
11	1	MS-3	A-101070	SHANK STOP PIN
10	2	MS-2	A-101067	FINGER PIN
8	1	MS-1-150	A-101062	SHANK SPRING 1.50 EXT
5	1	HS-60-P05-DZY	C-129888	NUT PLUNGER-HI-60 FOR PROX. PROBE-1.50 EXT. - SPECIAL
4	1	MPHS-60-04-DZY	C-129889	BACK-UP PLATE - ALT. MULTIPIERCE
3	1	MPHSM-22-AB03-DZC	D-129576	PUNCH SUPPORT CAM-BASE AIR BLOW-METRIC MTG. - SPECIAL

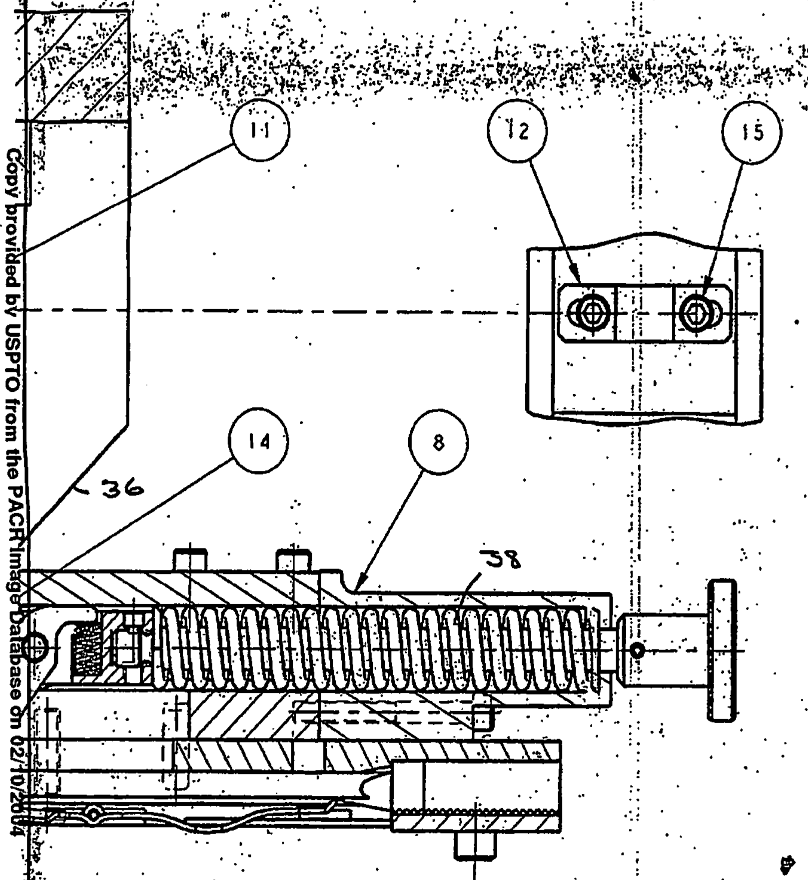
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	MM	INCHES
1 PLACE DIMENSIONS (.X)	±0.25	±.08
2 PLACE DIMENSIONS (.XX)	±0.13	±.01
3 PLACE DIMENSIONS (.XXX)	±0.03	±.005
ANGLES	±1°	±1°
CENTRAL (T.I.R.)	0.25	.010
SURFACE FINISH	3.2 µm	125 µin
REMOVE BURRS & BREAK ALL EDGES	0.25 MAX	.01 MAX
LOCATION BETWEEN DOWELS	±0.013	±.0005
LOCATION BETWEEN SCREWS	±0.13	±.005

3rd ANGLE PROJECTION

MULTIFASTENER® ENGINEERING

FABRISTEEL PRODUCTS INC.
22100 TROLLEY IND. DR.
TAYLOR, MI 48180-1872

DESCRIPTION	Sheet 2 HEAD ASSY - HI-60 1.50 EXT. - SPECIAL	ASSY No. -	UNITS ARE INCHES CAD IS THE MASTER
		E.W.O. 11208	SCALE 1:1
DRAWN BY G.H. DATE 8-7-01	PART No. HSNCM-60-PNPT00-DZY	DRAWING No. D-129887	
CHKD DATE 8-7-01			
APVD DATE 8-7-01			



SECTION Z-Z

Figure 4

Sheet 1

UNCONTROLLED

DET	QTY	PART No.	DRAWING No.	DESCRIPTION
27	1			SOC HD CAP SCR - M10 X 1.5P X 70m LG
26	2	[illegible]	[illegible]	SOC HD CAP SCR - M10 X 1.5P X 45mm LG
25	2	[illegible]	[illegible]	DOWEL PIN Ø10mm X 60mm LG
24	1	MS-183	A-502951	HOSE FITTING #10-32 TO 1/4 - 30
23	1	MSE-05	A-101477	TUBING
22	1	EP-COM-22-50	B-131074	SLUG PROBE ROD 0.50 EXT
21	1	129602	B-129602	MOLDED URETHANE SPRING
20	1	503130	A-503130	COMPRESSION SPRING
19	1	503053	A-503053	TURCK - PROX
18	1	502979	A-502979	PARKER O-RING (42-021)
17	1	MS-20	A-500172	PLUG 1/8-27 NPT
16	2	500028	A-500028	SOC HD CAP SCR #10-32 X 1.0 LG
15	2	MS-16	A-500004	SOC HD CAP SCR #10-32 X 3/8 LG
14	2	MS-14	A-500002	SHCS 3/8-24 UNF-2A THD X 1.50 LG.
13	1	MS-5	A-101078	CHUTE ATTACHING BLOCK LOCK PIN
12	1	MS-4H	A-103973	RETAINER PLATE STOP PIN
11	1	MS-3	A-101070	SHANK STOP PIN
10	2	MS-2	A-101067	FINGER PIN
9	1	MS-L-125	A-101061	SHANK SPRING 1.25 EXT
8	1	HSHC-60-29	C-104703	REEL FEED ADAPTER ASSY
7	1	503092	A-503092	PROX PROBE
6	2	HS-60-06	B-104182	NUT HOLDER FINGER HI 60 NUT
5	1	EP-60-P05-50	C-131103	NUT PLUNGER-HI-60 FOR PROX. PROBE - .50 EXT - E.P.
4	1	EP-COM-04	B-131069	BACK-UP PLATE MULTIPIERCE - E.P.
3	1	EP-COM-03	D-131068	PUNCH SUPPORT CAM BASE METRIC MTG. - E.P.
2	1	EP-COM-02-50	D-131067	SHANK - .50 EXT ERROR PROOFING
1	1	EP-60-PT01-50	C-131100	HOSE ASSY FOR HI-60 .50 EXT. - W/ PROX & T-BAR

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	MM	INCHES
1 PLACE DIMENSIONS (.X)	±0.25	±.06
2 PLACE DIMENSIONS (.XX)	±0.13	±.01
3 PLACE DIMENSIONS (.XXX)	±0.03	±.005
ANGLES	±0°	±1°
CENTRAL (T.I.R.)	0.25	.010
SURFACE FINISH	3.2 μm	125 μin
REMOVE BURRS & BREAK ALL EDGES	0.25 MAX	.01 MAX
LOCATION BETWEEN DOWELS	±0.013	±.0005
LOCATION BETWEEN SCREWS	±0.13	±.005

3rd ANGLE PROJECTION

MULTIFASTENER® ENGINEERING

FABRISTEEL PRODUCTS INC.
22100 TROLLEY IND. DR.
TAYLOR, MI 48180-1872

DESCRIPTION: Sheet 1 HEAD ASSY - HI-60 .50 EXT. - ERROR PROOFING

ASSY No.: -
E.W.O.: -
UNITS ARE INCHES CAD IS THE MASTER
SCALE 1:1

DRAWN BY G.N. DATE 10-3-02
CHKD DATE 10-3-02
APVD DATE 10-3-02

PART No. EPW-60-PNP00-50
DRAWING No. D-131099

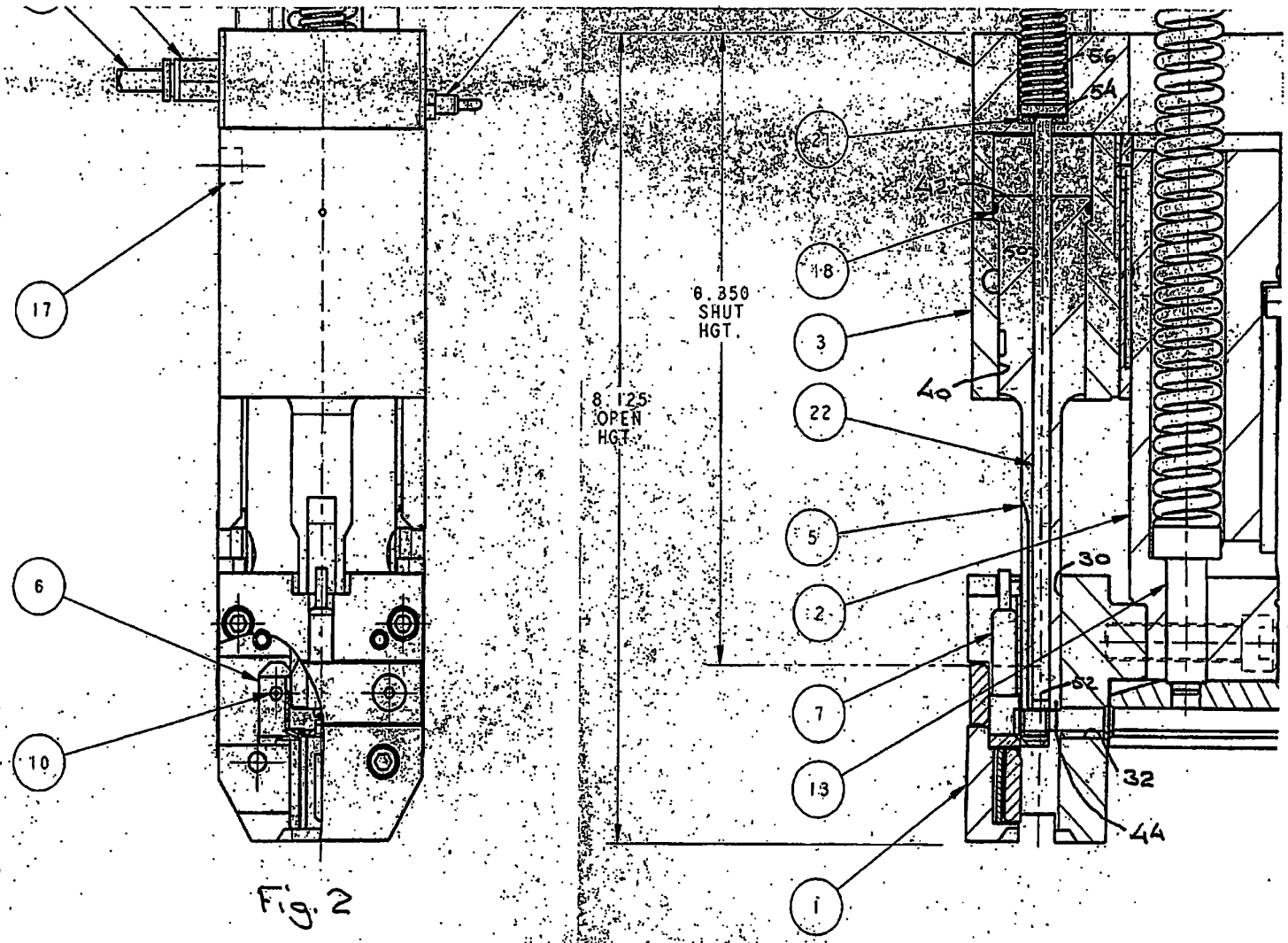


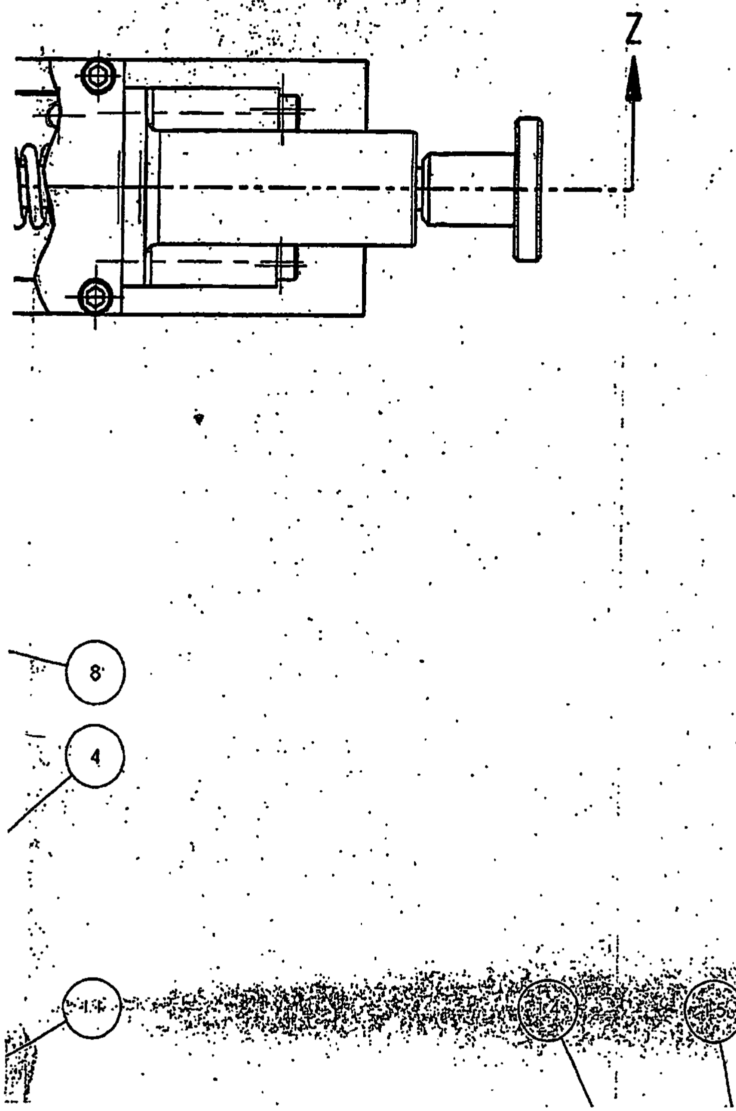
Fig. 2

▽ NOT FURNISHED WITH HEAD ASSEMBLY SHOWN FOR REFERENCE ONLY

▽ PERMANENTLY AND LEGIBLY MARK "ASSY No." WHERE INDICATED

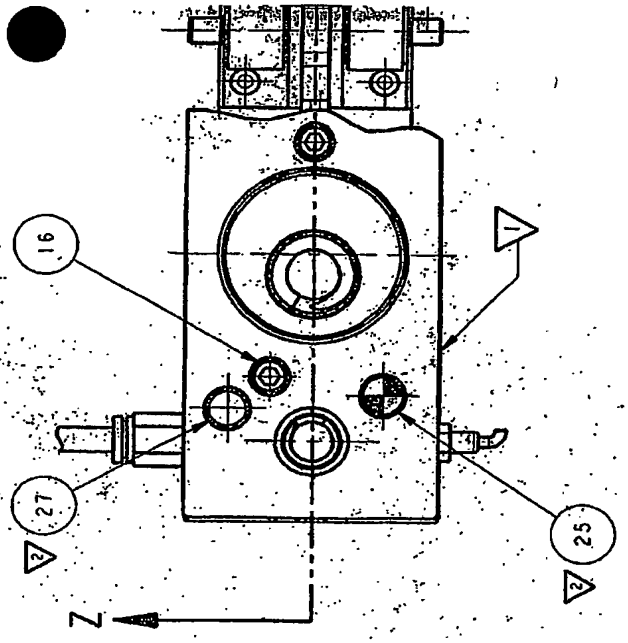
ALL GEOMETRIC DIMENSIONING & TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994

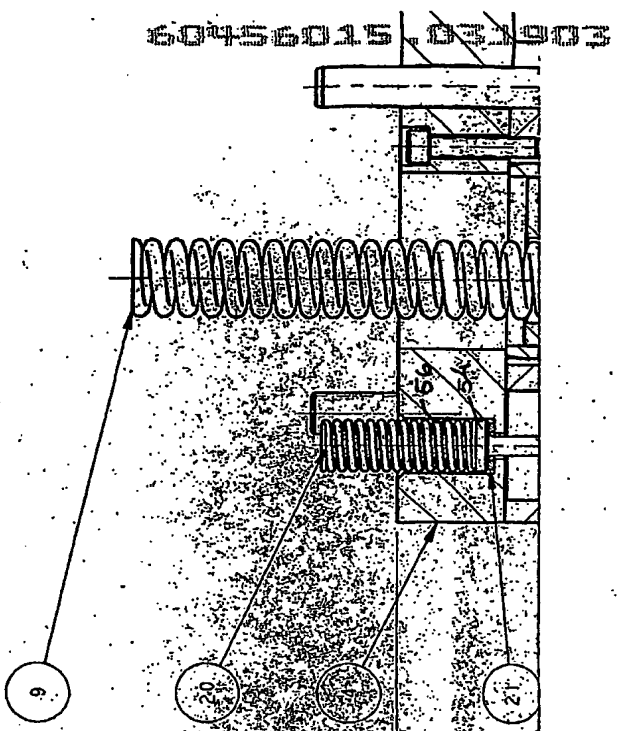
LET.	E.C.N.	E.N.O.	CHANGE	BY	APVD	DATE

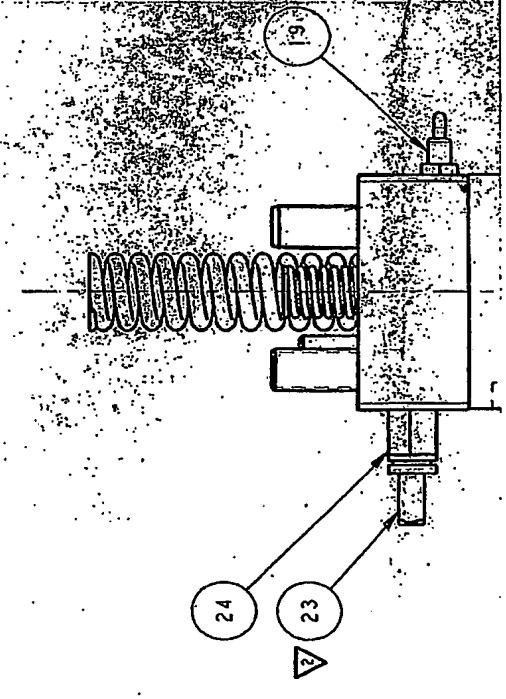


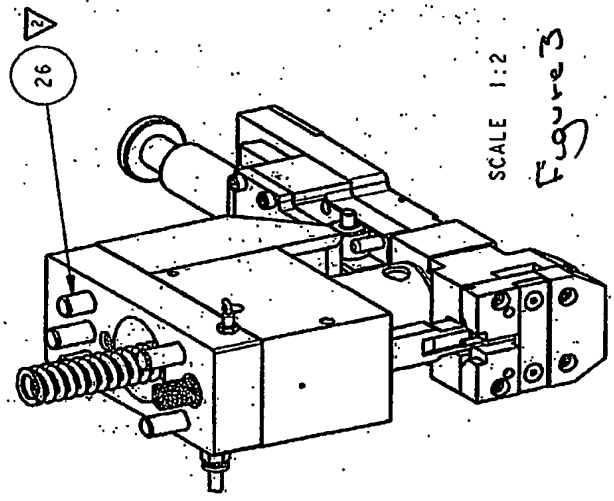
FOR GM LANSING

36	3			SOC HD CAP SCR M10 X 1.5P X 60mm LG
35	2			DOWEL PIN Ø10mm X 60mm LG
34	1	HS-60-PT01-CT	C-125018-A	ALT. HOSE ASSY FOR HI-60 1.50 EXT. W/ PROX & T-BAR
33	1	129890	C-129890	SLUG PROBE ROD
32	1	NP-COM-02-150	C-104782	SHANK - 1.50 EXT
31	1	HSNC-60-29	C-104703	REEL FEED ADAPTER ASSY
30	1	129355	B-129355	PROBE RETAINER
29	1	[illegible]	[illegible]	PROX ASSY



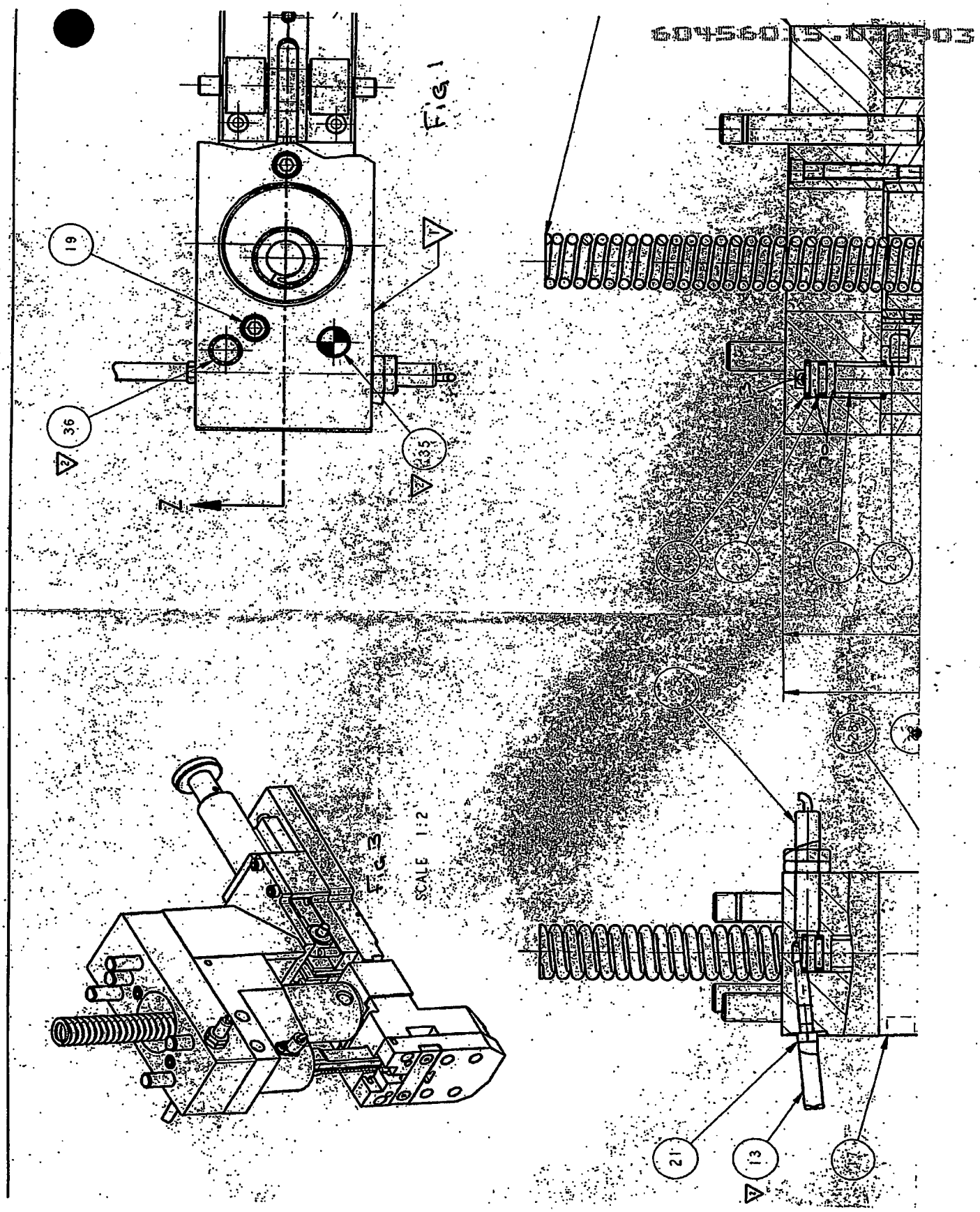






SCALE 1:2

Figure 3



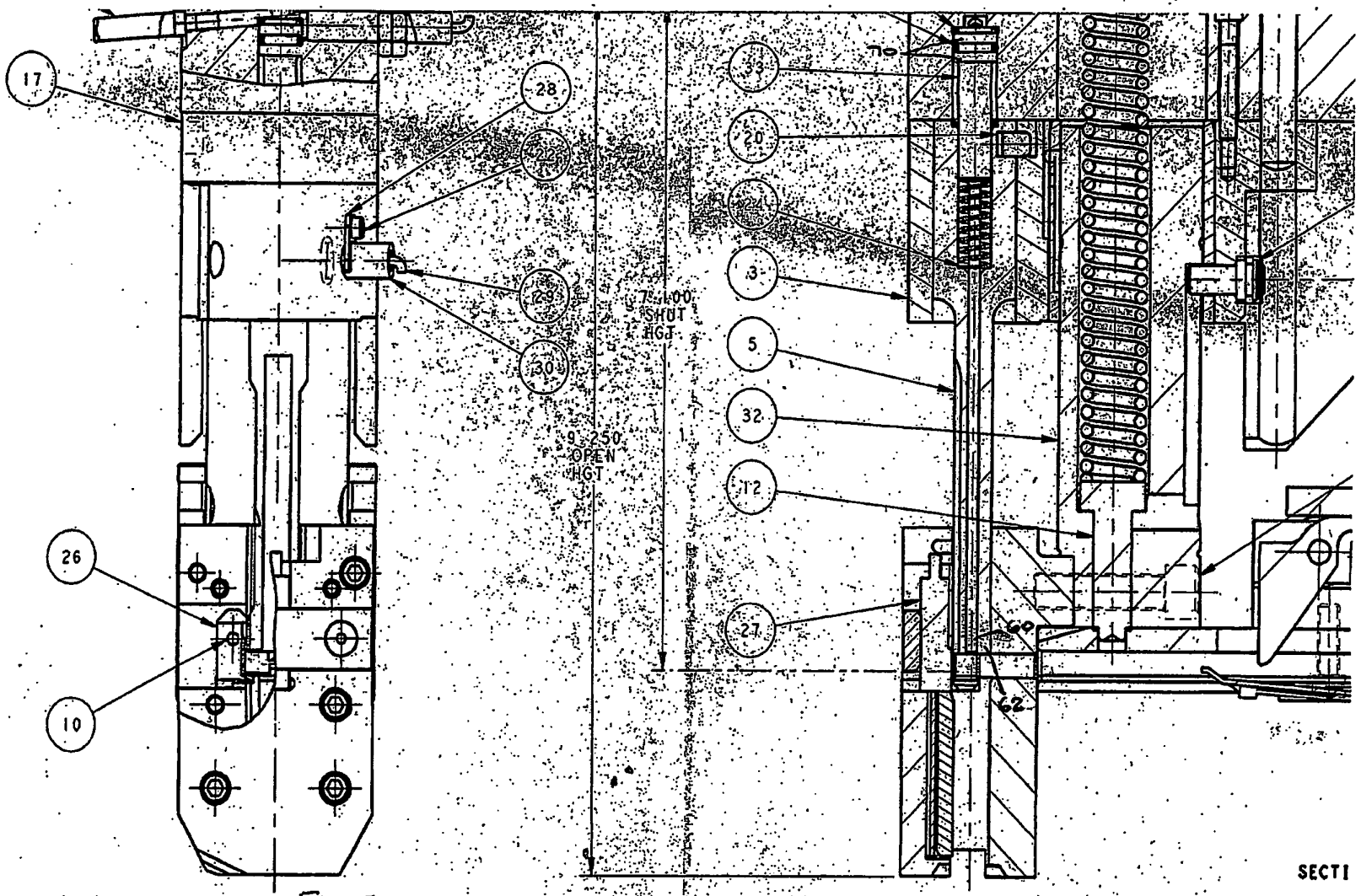


Fig. 2

▽ NOT FURNISHED WITH HEAD ASSEMBLY SHOWN FOR REFERENCE ONLY

▽ PERMANENTLY AND LEGIBLY MARK "ASSY No." WHERE INDICATED

ALL GEOMETRIC DIMENSIONING & TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

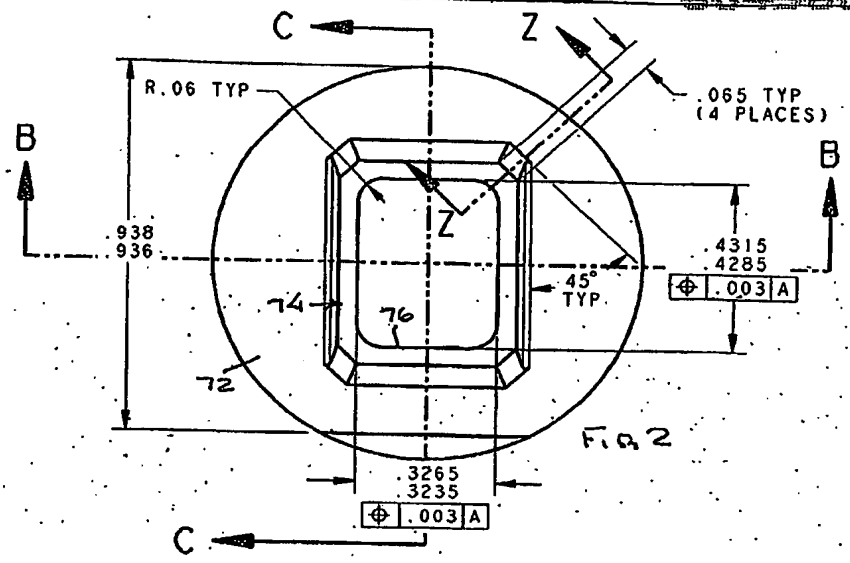


Fig 2

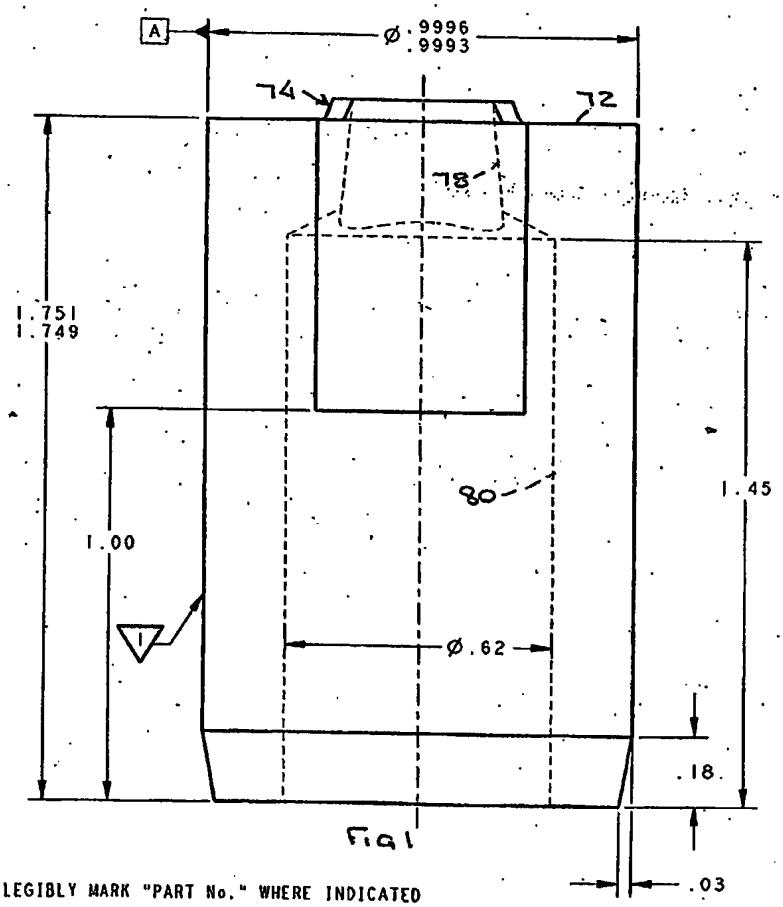
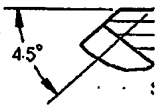


Fig 1



F

▽ PERMANENTLY AND LEGIBLY MARK "PART No." WHERE INDICATED

LET.	E.C.N.	E.W.O.	CHANGE	BY	APVD	DATE

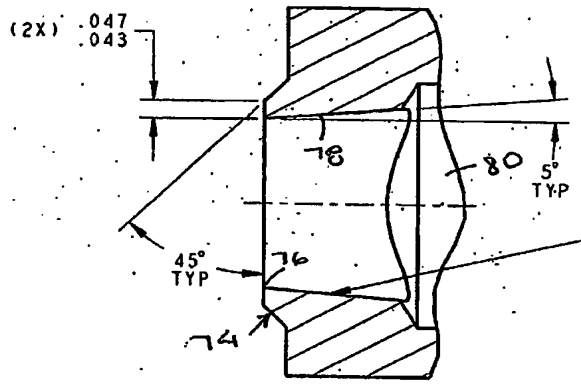
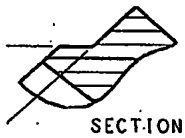


Fig 4

SECTION C-C



SECTION Z-Z

Fig 5

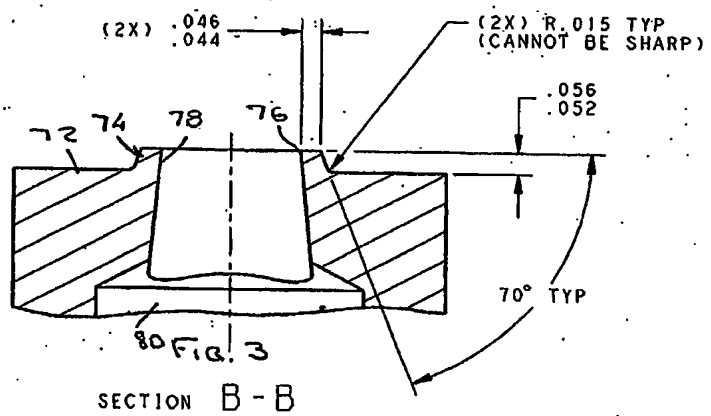


Fig 3

SECTION B-B

Sheet 3

UNCONTROLLED

MAT'L - AISI S7 TOOL STEEL

DOUBLE DRAW
HARDEN: Rc 52-54

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	MM	INCHES
1 PLACE DIMENSIONS (.X)	±0.25	±.06
2 PLACE DIMENSIONS (.XX)	±0.13	±.01
3 PLACE DIMENSIONS (.XXX)	±0.03	±.005
ANGLES	±1°	±1°
CENTRAL (T.I.R.)	0.25	.010
SURFACE FINISH	3.2 µm	125 µin
REMOVE BURRS & BREAK ALL EDGES	0.25 MAX	.01 MAX
LOCATION BETWEEN DOWELS	±0.013	±.0005
LOCATION BETWEEN SCREWS	±0.13	±.005

MULTIFASTENER® ENGINEERING

FABRISTEEL PRODUCTS INC.
22100 TROLLEY IND. DR.
TAYLOR, MI 48180-1872

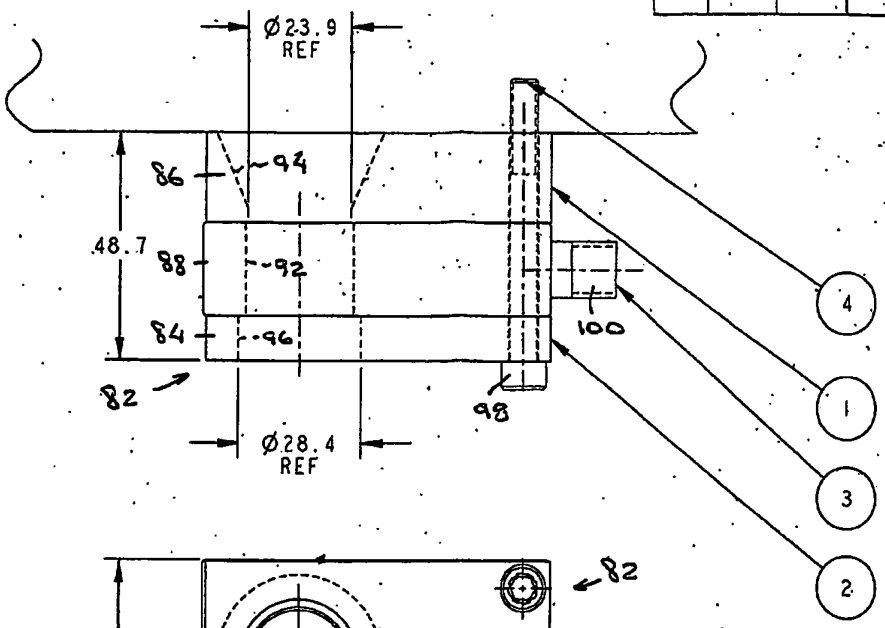
DESCRIPTION
DIE BUTTON-H160
FOR .025-.045 [.64-1.16] METAL

ASSY No. -
E.W.O. -
UNITS ARE INCHES CAD IS THE MASTER
SCALE 4:1

3rd ANGLE PROJECTION

DRAWN BY G.M. DATE 11-8-02
CHKD DATE 11-8-02
PART No.
DRAWING No.

LET.	E.C.N.	E.W.O.	CHANGE	BY	APVD	DATE



[2] UNCONTROLLED

Sheet 4

DET	QTY	PART No.	DRAWING No.	DESCRIPTION
4	2			SOC HD CAP SCR - M6 X 1.0P X 60mm LG
3	1	502976	A-502976	BALLUFF RING SENSOR
2	1	131308	B-131308	RISER PLATE- LOWER
1	1	131312	B-131312	RISER PLATE- UPPER

Sheet 4

[2] NOT FURNISHED WITH ASSEMBLY
SHOWN FOR REFERENCE ONLY

ALL GEOMETRIC DIMENSIONING & TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	MM	INCHES
1 PLACE DIMENSIONS (.X)	±0.25	±.06
2 PLACE DIMENSIONS (.XX)	±0.13	±.01
3 PLACE DIMENSIONS (.XXX)	±0.03	±.005
ANGLES	±1°	±1°
CENTRAL (T.I.R.)	0.25	.010
SURFACE FINISH	3.2 µm	125 µin
REMOVE BURRS & BREAK ALL EDGES	0.25 MAX	.01 MAX
LOCATION BETWEEN DOWELS	±0.013	±.0005
LOCATION BETWEEN SCREWS	±0.13	±.005

3rd ANGLE PROJECTION

MULTIFASTENER® ENGINEERING

FABRISTEEL PRODUCTS INC.
22100 TROLLEY IND. DR.
TAYLOR, MI 48180-1872

DESCRIPTION: SENSOR FOR SLUG DETECTION

ASSY No. -
E.W.O. -
UNITS ARE AS CAD IS THE MASTER
SCALE 1:1

DRAWN BY G.M.	DATE 1-23-03	PART No. 131311
CHKD	DATE 1-23-03	
APVD	DATE 1-23-03	

DRAWING No. B-131311

1. When the Pierce Nut is automatically placed in the installation Head, the "Slug Probe Rod" is in the "Start" position.

2. As the die closes, the Nut Plunger pushes the Pierce Nut Pilot through the Metal panel. The "Slug Probe Rod" contacts the "metal slug" and applies a pushing force to the slug.

3. The die-stamped blank (slug), cut by the Nut pilot, is pushed through the die button. A proximity probe, Located in the installation Head, senses the position of the "Slug Probe Rod" at bottom of press stroke. Also, a proximity ring sensor, located at bottom of die button retainer, senses the "Slug" as it drops through the die button.)

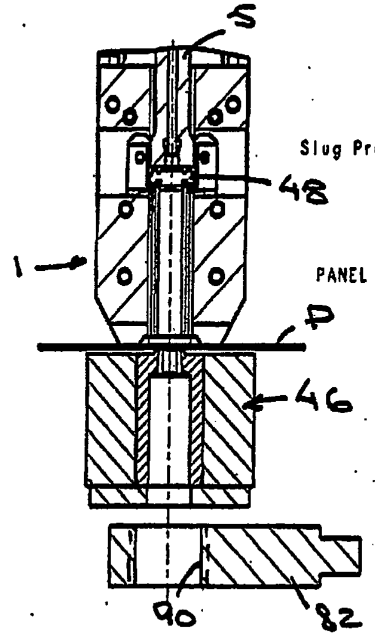


FIG. 1

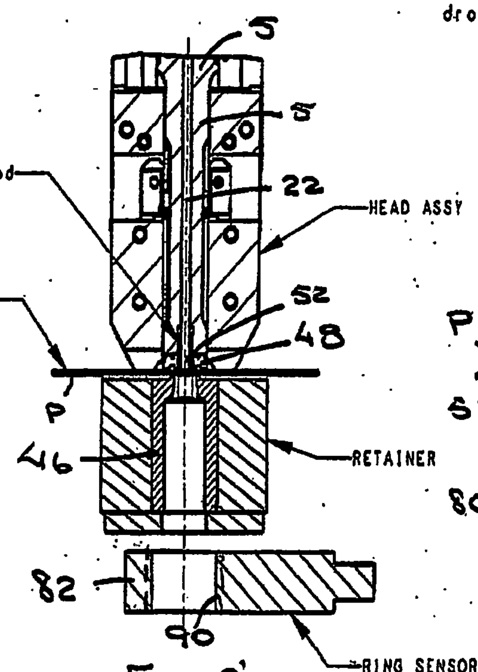


FIG. 2

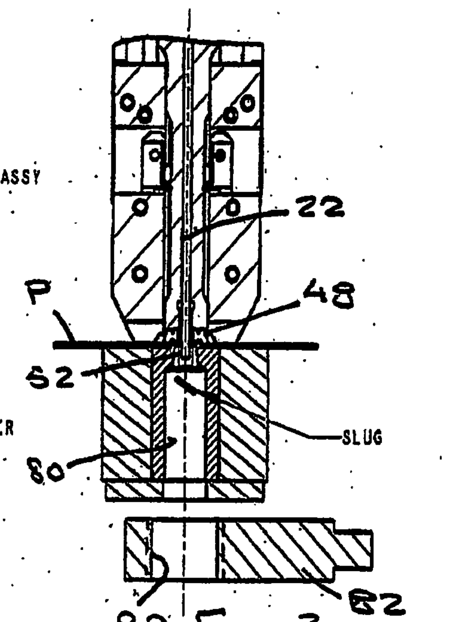


FIG. 3

Sheet 5

INSTALLATION HEAD

MULTIFASTENER
ENGINEERING

FABRISTEEL PRODUCTS INC.
22100 TROLLEY IND. DR.
TAYLOR, MI 48180-1872